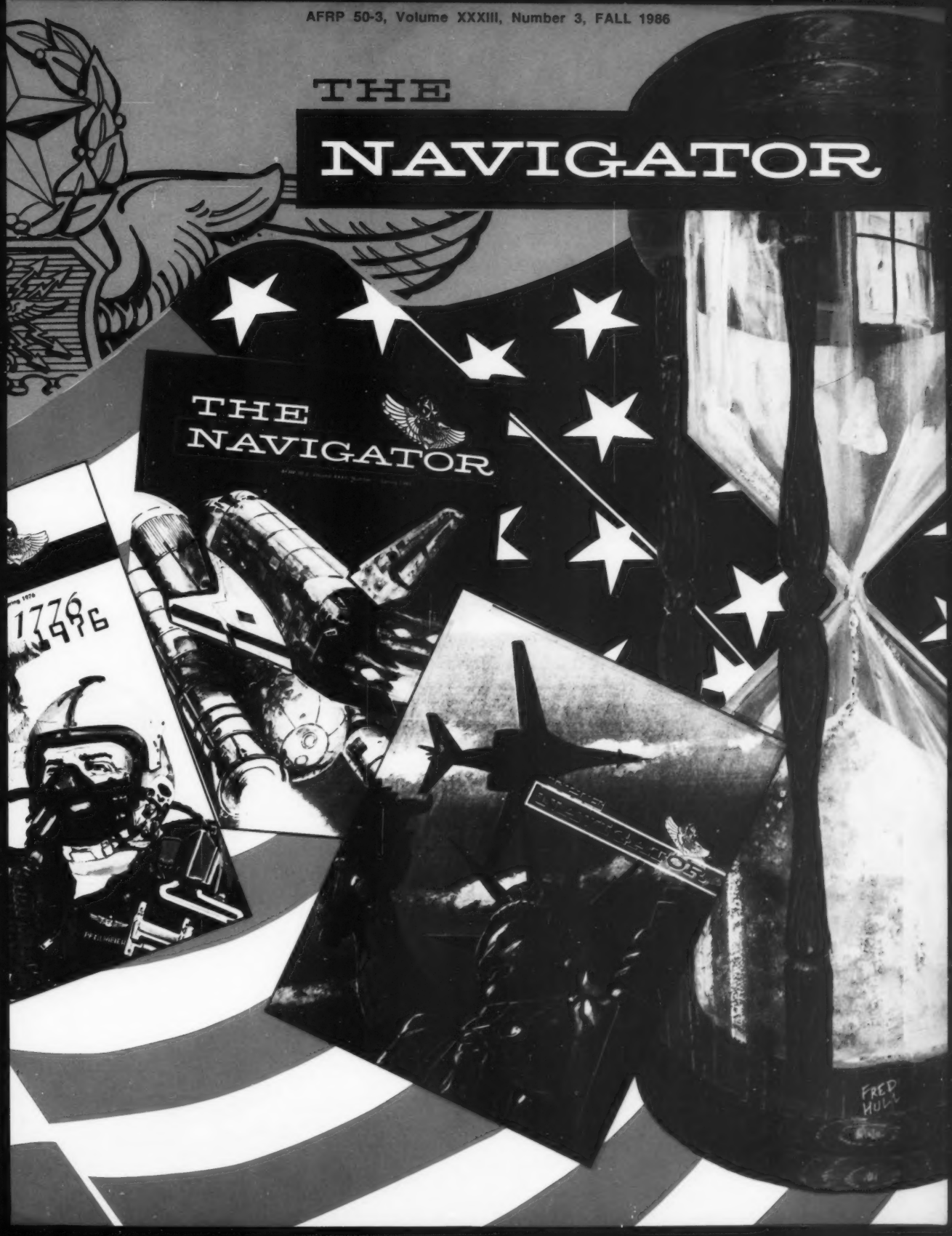
AFRP 50-3, Volume XXXIII, Number 3, FALL 1986

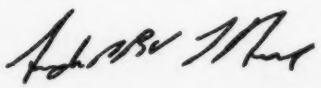
THE NAVIGATOR



This is the LAST EDITION of THE NAVIGATOR magazine

As a result of periodical cost reductions, THE NAVIGATOR magazine has been cancelled.

I wanted this issue to be the best-of-the-best. Digging through the past issues I found articles covering all aspects of the navigator field; everything from the duties of a B-36 crew member to the duties of an F-15E Strike Eagle crew member, navigating a nuclear submarine below the North Pole and navigating the SR-71 above 80,000 feet. I decided the best tribute to the field would be one that emphasizes our proud past, our professionalism, and our future. How would you like to fly in an aircraft that takes off using seven million pounds of thrust, burns fuel at a rate of 10 tons per second, and takes eight minutes to attain a speed of 17,000 miles per hour? Colonel Richard M. Mullane has done just that. Share his experiences as the first navigator in space. Another navigator who has done his fellow flyers proud was the leading ace in the Vietnam conflict, Colonel Charles B. DeBellevue. During an interview, May 1983, he recalls what it was like, "You come out first or you don't go home." Also in this issue, the words still hold true of former ATC Commander and USAF Vice Chief of Staff, General William V. McBride, to a graduating navigator class, "No matter what job an individual is given, the best chance for him to succeed and to progress lies with his willingness to do the very best he is able." In an article from our Summer 1978 issue, Anyone Can Navigate, Lieutenant Colonel Thomas D. Bandler, USAF Retired, gives us a personal account of what it really took to be a great navigator during World War II. There's more. So sit down and read about where you've been and where you're going.



This being the last issue of THE NAVIGATOR magazine, I would like to recognize the past editors. They are listed with the rank held while editor and the years served in that position. I wish to express special thanks to Captain Joseph F. Sage for his efforts and dedication in creating the magazine.

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Department of the Air Force

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Proudly Serving Air Force Navigators Around the World Since 1953

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In its 33 years, THE NAVIGATOR magazine has informed, enlightened, and improved the flying warrior.

AFRP 50-3

Distribution: One copy per four navigators.

Reprinted from the Spring 1985 issue

FLYING THE SHUTTLE

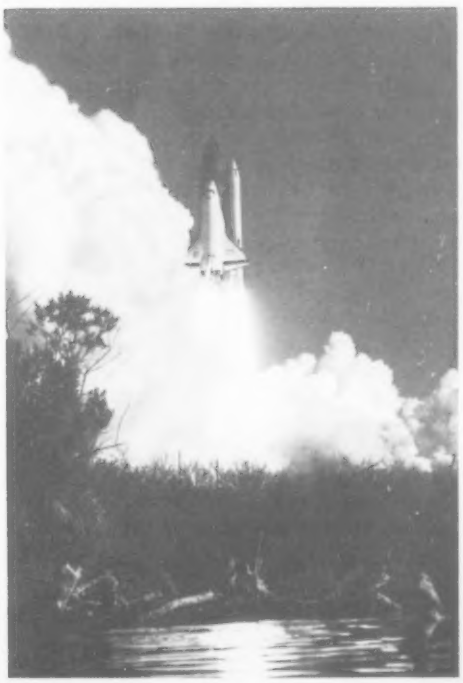
Colonel Richard M. MULLANE
NASA/Johnson Space Center
Houston, TX

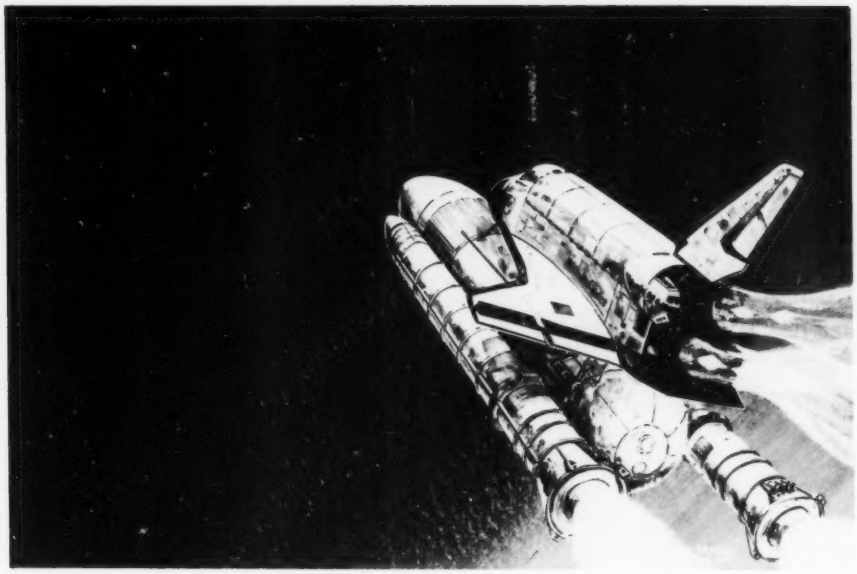
The simulator had done a superb job of preparing us for the mission, but, as with any simulation, it had its limits. The feeling of one million pounds of thrust coming to life 100 ft behind your back cannot be adequately simulated nor properly described. The vehicle is held to the pad while four computers check the health of the three liquid-fueled engines. Fortunately, this time, 30 August 1984, there are no engine anomalies. Our launch attempt two months earlier was aborted four seconds prior to liftoff because of an engine valve malfunction.

At solid rocket booster (SRB) ignition there is no doubt about the fact you are leaving this planet. The vibrations increase significantly as the combined seven million pounds of thrust rapidly lift us clear of the gantry. During the next two minutes Discovery's solid-fueled engines will consume fuel at the rate of 10 tons per second. Some afterburner!

As a crew, we are in a monitor mode for the Shuttle ascent. If all goes well, only one switch action (which changes the function of the ADI) will occur during the 8½ minutes it takes to reach 80 nm altitude and 25,670 ft per second velocity. As we have done in over 400 simulations in the previous 18 months, we will monitor the ascent and intervene only if problems occur.

As Mission Specialist 1 (MS1) I'm sitting on the right side of the cockpit directly behind the pilot, Navy Cdr Mike Coats. To my immediate left is Steve Hawley, MS2, a civilian





astrophysicist. Between us we carry the detailed checklist procedures to be invoked if any malfunction occurs. We are much more than librarians, however. Ascent events are so time critical and the vehicle is so complicated that we have trained with the pilots in orchestrating the response to any Shuttle problem with little or no reference to the malfunction checklists. The Commander, Hank Hartsfield, a retired USAF colonel and former F-105 driver, sits in the forward left seat. In the mid-deck beneath our feet sit the other two crew members: Judy Resnik, MS3, an electrical engineer, and Charlie Walker, a McDonnell Douglas employee, flying as a passenger to operate his company's pharmaceutical manufacturing experiment.

In just 18,000 ft of vertical travel our 4½ million lb machine is already supersonic. By SRB burnout at two minutes into the flight, we are well above the atmosphere and the ride becomes extremely smooth. In fact, people have likened it to being propelled into space by an electric dynamo. There is no noise, just a steady buildup of G-forces.

At four minutes into the flight, the sky is all we can see out the forward windows and it is already totally black. But, by twisting my head around and looking through the overhead window I'm able to catch a glimpse of the sunlit earth 60 miles below. The view is incredible! Scattered cumulus clouds are like tiny white dots on an expanse of deep blue ocean. It is a sight, along with many sights of the next six days, that will be forever etched in my memory.

At about 7½ minutes into the flight the engines are throttled down to limit acceleration to 3-G's—not very impressive to you fighter types. But the Shuttle is built light and can't take much more. Then, at 8½ minutes, the engines are shut down and the G-forces stop instantaneously, to be replaced immediately by weightlessness. While still strapped to our seats, the feeling of O-G is identical to that sensed in aircraft maneuvers, only this time it continues.

At this point we still lack about 240 ft per second additional velocity to achieve orbit. Without it, we would follow our jettisoned external fuel tank into the Indian Ocean. For that reason it is a wonderful feeling to sense the orbital maneuvering system (OMS) engines ignite at 10 minutes into the flight to pick up that additional velocity.

After this burn, I unstrap to move to an aft panel to throw a couple of switches and get my first taste of unrestrained 0-G. In just seconds I'm out of control bouncing from object to object. It's readily apparent why we protect the switches in the cockpit with guards. The adaptation to the dynamics of 0-G movement is fairly rapid and within a couple of hours you are able to make controlled translations around the vehicle. The trick is to move slowly—very slowly.

After a second burn of our OMS engines at 45 minutes into the flight, we are safely in a 169 nm orbit. It has taken 27 years from the birth of this country's manned space flight effort, but the USAF navigator community has finally been represented in space.

In 1976, I was a student attending the Flight Test Engineer Course of the USAF Test Pilot School at Edwards AFB, California, when NASA opened the door to navigator participation in the Astronaut Program. Although the first flight of a Space Shuttle was still five years away, NASA announced at that time the start of a selection process for the group of Shuttle-era astronauts. Significantly for the navigator community, the NASA announcement specified that, in addition to selecting pilots for Shuttle operations, individuals with no piloting background would be selected to serve as MSs onboard the Shuttle. The duties of the MS would be to assist the pilots in monitoring Shuttle systems during all flight phases and to direct the orbit activities, typically the checkout and deployment of satellites and/or the operation of onboard experiments. Also, MSs would be the primary crew members to perform any required extra vehicular activity (EVA), or space walks. This was the first time in the history of the US Space Program that NASA designated a non-pilot astronaut crew position. In past selections, only pilots, or scientists who NASA intended to train as pilots, were selected for space flight.

Within several months of this initial announcement, NASA released the eligibility criteria for the MS astronaut position. Basically the requirements were an engineering, science or mathematics undergraduate degree with three years of related experience and sufficient health to pass a Class II flight physical. An advanced degree was desired and could be substituted for the experience requirement.

Having earned a Master of Science Degree in Aeronautical Engineering thru AFIT and being healthy enough to be on flying status, I felt I met these qualifications and submitted my application through USAF channels. I was fortunate enough to make it through the AF selection process and my name was submitted to NASA for consideration. In January 1978, NASA announced the first 35 Shuttle-era astronauts of which I was one of the MSs named. Needless to say, I bought the beer that night at the club.

I would like to think that many other navs will follow me into the astronaut program. As systems operators in some very sophisticated aircraft and having to deal routinely with time-critical situations in demanding flight environments, we have unique expertise to offer to the Manned Space Flight Program. And it's my intention, via this article, to get the word out to as many people as possible that they have the opportunity to fly as astronauts.

I'm not certain what resulted in my selection over other applicants but I do know it wasn't because I had a one-of-a-kind career that will never be repeated. I had no assignment, except, of course, the Vietnam tour, that isn't still available to virtually every nav. I don't think my RF-4 background was all that important to my selection, so people in the heavies shouldn't think they aren't competitive. However, I am certain getting a Master of Science Degree was of great importance. While NASA only requires an undergraduate degree for eligibility, almost every MS selected has at least a master's degree and many have a PhD. I also believe that completing the engineer course of the USAF Test Pilot School makes you more competitive. All three of the non-pilot USAF personnel selected to date as MSs (myself and two flight test engineers) have been graduates of that course. I would strongly encourage everybody interested in getting into the astronaut program to consider those two assignments. Even if it doesn't get you selected as an astronaut it will enhance your career opportunities both in and out of the AF. You can't lose!

But if you are selected as an astronaut, what can you expect? First of all, the agreement NASA currently has with the DOD is that you are loaned to NASA for a period of seven years, with an option for a one-year extension. The DOD 1978 selectees have been extended two additional years. Your OERs are written by the Chief of the Astronaut Office and endorsed by the Johnson Space Center Director and by the DCS for Research, Development and Acquisition, a three star general position.

For your first year you are designated an Astronaut Candidate and undergo an evaluation by NASA. Forget the "Right Stuff" movie scenes. This evaluation is informal and transparent to you. Basically, it just allows NASA and you to adapt to each other and gives

you time to decide if you really want to spend a significant part of your career working for a civilian agency.

During this candidacy period you spend some time in classroom lectures. Did I say classroom? Relax, you are not tested on the material presented. The profs are experts in various fields of science, e.g., geology, astronomy, oceanography, and meteorology, to name just a few. Their objective is to make everybody aware of what is going on in their respective fields and to tell you how manned space flight can aid them. It's surprising what a trained observer can do from a low earth orbit for these folks.

The other part of the classroom work consists of briefings on the Space Shuttle itself. These briefings do not make you an expert on the Shuttle, they just give you a basic understanding of the systems. The vehicle is so complicated and the systems are integrated with each other to such a degree that you don't achieve expert status until you train for flight in the Shuttle simulator. More on that later.

In your first weeks everybody will go through standard physiological training and transition into T-38 flying—a piece of cake for any nav. Your flying will be as backseaters only. NASA does not train you as a pilot. Each year you will be required to take a proficiency flight check and written exam. Stan/Eval is everywhere. You can never get away.

In your first year you will travel to the other NASA centers and some of the major shuttle contractors to get briefings on what they are doing. Remember, you are a representative of NASA and should be aware of all of their activities. As an astronaut you will become a highly visible spokesperson for NASA.

Just as you can never escape the clutches of Stan/Eval you can never get away from the flight surgeon. As a candidate and throughout your stay with NASA, you will be required to take an annual flight physical. I only mention this because so many people have the misconception that you have to be a world class athlete to be an astronaut—not true. You must stay in shape to pass the physical, which is very similar to a normal USAF flight physical, except for a very rigorous cardiovascular exam. How you stay in shape is entirely up to you. NASA has no formal physical training program.

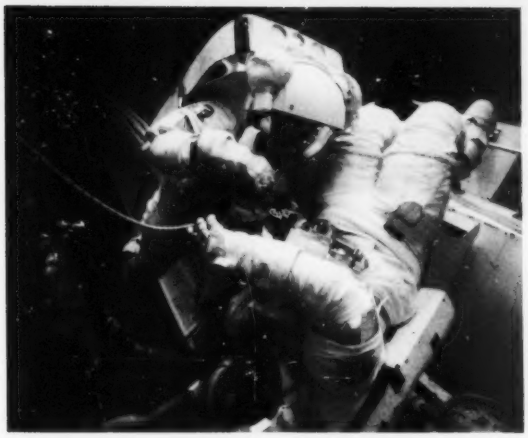
At the end of your first year, you'll be designated a NASA astronaut but probably you'll still be a couple of years away from your first flight. What do you do during this time? Like any USAF flying unit the astronaut office has a multitude of additional duties that must be performed by crew members. You'll spend most of your time assigned to cover these jobs. They are not trivial in nature. Each is critically important to the Space Shuttle Program and each provides you with training directly applicable to the flight assignments you will be receiving. For example, one job you may be assigned is performing crew duties in the cockpit of the Shuttle Avionics Integration Lab (SAIL). This lab is an exact avionics duplicate of the Space Shuttle and all avionics hardware and software that flies on the Shuttle is first thoroughly tested in this lab. As an astronaut, you will sit in the cockpit and "fly" simulated ascent, on-orbit, and entry test cases. You will be responsible for documenting any anomalies so they can be corrected by the appropriate engineering personnel. Even though you are an MS, you perform all crew duties during these tests including the piloting tasks. This exposure to the hardware and software is tremendously helpful later when you enter formal training for a flight.

Another typical job assignment would be as a "Cape Crusader," as we affectionately refer to the cadre of astronauts who support Shuttle checkout and preparations for flight at Cape Kennedy. Once again you will be in the cockpit doing all crew procedures for a test—a superb training experience.

Also, new payloads being developed for Shuttle flight require significant astronaut support. We want to be certain the contractors provide the crew members with the interfaces needed to do the job the payload is designed to perform. As an AF astronaut, you might be assigned to track the development of a DOD payload.

Astronauts also develop and test EVA procedures and equipment in a large swimming pool used to simulate weightlessness. Evaluating the never-ending changes to the Shuttle software for its impact on crew procedures is also performed by astronaut personnel. All of the interface between the ground and a crew in orbit, including voice communication, is done by astronauts who are members of the Mission Control Center Team.

I could list many other jobs, each of which requires full-time astronaut support and is critical to the success of the overall Shuttle



program. You will thoroughly enjoy every one of these jobs while awaiting your turn for a flight.When will that occur and how often? Probably much quicker and more frequently for 1990 era astronauts than for us 1978 selectees.

The first of my contemporaries flew about five years after entry into the program. It is anticipated that by our seventh year all 35 of us will have had our first flight. Some will have had their second. For the next couple of years an individual's sortie rate will probably be about one per year. The reason I doubt that any astronauts selected in coming years will have to wait this long is because of the rapidly expanding mission rate. In 1984, NASA flew five Shuttle missions. The schedule includes 12 for 1985 and 14 for 1986. By mid-1985 NASA will take delivery of its fourth Shuttle, Atlantis, and Columbia will rejoin the fleet after 18 months of extensive modifications. Also, in 1985 NASA and USAF will begin launch operations from Vandenberg AFB. In 1986, a second launch facility will begin operations at the Kennedy Space Center. DOD operations from both the East and West Coast sites will begin to expand in future years. As USAF astronauts, you certainly will have an excellent opportunity to participate in these flights. Also, commercial operations are expected to demand more and more Shuttle space. A space station is now being developed and will be operational in 8 to 10 years. Construction and routine support of this station will undoubtedly require additional Shuttle flights. All of this says to me that the 92-member astronaut office will have to expand in future years and those people joining the program will fly quickly and frequently.

Once selected for a flight, which generally occurs about a year prior to launch, you will hand over your other jobs and become a participant, along with the rest of your crew and the Mission Control Center Team, in probably the most demanding and thorough training program in existence. It has to be that way. Keep in mind that on any Shuttle flight, one quarter of this nation's launch capability, representing billions of dollars, and the lives of the crew are exposed to the hazards of space flight. With this magnitude of commitment NASA takes the same attitude that any wing commander would take with a similar commitment of his resources to a single mission, i.e., to make sure everybody playing a part in the mission is thoroughly trained. Obviously, the wing commander can insure the desired level of preparation by relying heavily on actual flight operations. NASA enjoys no such luxury. We must rely totally on simulations.

To fulfill this need, NASA has constructed two shuttle mission simulators at the Johnson Space Center that, as nearly as is humanly possible, duplicate the environment of space flight. The cockpits are exact duplicates of the orbiter cockpits. Digitally-generated scenes give the pilots views of launch and landing areas and, for rendezvous missions, views of

the rendezvous targets. For on-orbit simulations these computer-generated scenes give the MSs a view of the cargo bay with its payloads and scenes of deployed satellites. Even the stars are projected so that manual procedures for aligning our inertial units can be practiced—don't forget your star identification. One of the simulators has a hydraulic system that duplicates the launch and entry motion cues. For long on-orbit simulations the crew will prepare and eat meals using the Shuttle meal preparation hardware and flight food packages. Even a duplicate of the Shuttle toilet is available for training. Everything that can be simulated is simulated. Training emphasis is on malfunction detection, analysis and correction, in addition to normal operations. In the final months prior to launch you will literally meet yourself coming and going from the simulator. For my mission our crew had 426 launch simulations, 266 entry simulations, and 350 hours of orbit simulations. When you climb into the Shuttle on launch day, you will never be so prepared for a flight in all your life, nor will you ever enjoy a flight more.

I am frequently asked, "What is it like to be an astronaut?" I hope the above description has answered that question. I also hope that many of you will be inspired to pursue an astronaut tour by what I've written. Your opportunities are much more real than you suspect. And, as I said earlier, preparations for eligibility for an MS astronaut selection can only help your career. You can't lose! Keep your eyes open for NASA and USAF announcements on the astronaut program and apply. Good luck and fly safe!

Reprinted from the Summer 1978 issue

Anyone can navigate

Lt Col Thomas D. Bandler, USAF Retired

We had been shooting some stars just outside the Navigation School classroom in San Marcos, Texas. Well, that's not exactly right. I hadn't. But the other fellows had been looking through their A-10 sextant, a little gadget which makes stars visible to the naked eye, and neatly finding out through celestial navigation that we were standing just outside the Navigation School classroom in San Marcos, Texas.

But me, when I peered through the little glass opening of the sextant, all I could see was my own eye. No stars. No planets. No heavens even. Just my own eye.

Well, this wasn't too good. Not that it made much difference then for I felt pretty confident of our whereabouts at the time even without the sextant. But still and all, it made a navigational career seem somewhat hazy. It didn't bode too well for the future. Sooner or later, 10 innocent B-17 crew members might be dependent upon the dubious sextant of one slightly helpless navigator. We might be over an ocean someday. We might be lots of places. We might not always be just outside the classroom in San Marcos, Texas.

So I resigned from Navigation School. It was the noblest thing to do. It was the safest thing to do. But this was in early '43, a year when navigators were pretty scarce. The Air Force was reluctant to accept my resignation. No, they would get me a different sextant, an A-12, one a blind man could see through, one they trained seeing-eye dogs with. Which they did. And I could see. I graduated from Navigation School. I had my wings. I was a real navigator. I was ready.

Then they gave us our permanent equipment, the stuff we could keep forever, the stuff our lives depended on. And I got a sextant, all for me, a key to celestial navigating, the one which, it turned out, I kept all through my navigational career. The kind I couldn't see through!

The point of this article is that I never did become a better navigator than I was that day. But, through a quantity of errors, I eventually became a lead navigator of the 8th Air Force. I got the Distinguished Flying Cross. And I got lost in England, France, Holland, Belgium, and Germany.

And I was considered a hero. But I never could find my way in that airplane.

Well soon after leaving San Marcos we were assigned to the Overseas Training Unit in Gulfport, Mississippi. There we assembled into a complete B-17 crew, with which we theoretically would later go overseas and win the war. We flew long training flights daily--flights in a sort of follow-the-leader formation. There would be about 12 planes, with an experienced crew in the lead plane, and we followed the lead plane and tried to keep track of where he took us. This was also true in combat. You followed the lead plane and dropped bombs where he did. It seemed to me a highly satisfactory system, as long as I wasn't in the lead plane!

Anyhow, to sort of morphiate the boredom of our flights, we started listening to the commercial radio in our plane. This is an interesting gadget installed for various useful purposes, a by-product being that we could listen to local stations over wherever we were flying. For navigational purposes, it had a face like a clock and a single hand which pointed toward the station. In other words, if the ground station was ahead of you it would point north, or up, while if it were to your left, it would point left. Very simple. A child could figure it out. I could figure it out!

It was a good gadget, but it wouldn't work over oceans, over Germany, or, for that matter, over half the places in the U.S.A. It had a limited value. They told us, in fact, not to use it. It was the one navigational gimmick which, in the Army's opinion, was more or less worthless. It was the only one I could work.

From Gulfport to Memphis

Well, my crew was happily following the other 11 planes one merry morning when the incident occurred. We had been over clouds for about three hours, and, of course, I was lost. Naturally this was no surprise, but it was a terrible surprise when the pilot called up in some excitement to announce that the other 11 planes were also lost, and where were we? To this day, and faster than I could say "just a minute," which I promptly did, I have wondered why he ever asked me. He must have known I wouldn't have any idea. He must have been nervous.

About two minutes later he called again. He was quite excited. Something about low on gas. The other planes wanted to know. I felt no glow of opportunity, just my usual shame, and I repeated, "just a minute." In blind hope, however, I fiddled with the radio, my only friend. Well, believe it or not, the thing suddenly started playing music very loudly and pointing straight ahead. This meant we were very close to somewhere. I felt better. I knew more than I ever had before. I was warm. We were near somewhere. I felt like Confucius. I watched the needle and it started turning left very quickly. We were almost abreast of somewhere. The only detail missing was where. Suddenly the music stopped and the announcer said: "And next, as a tribute to the fighting men of Memphis, we will play their Victory March."

Well, this changed the picture. No longer were we near somewhere. We were either right above the outskirts of Memphis or else we were near anywhere in the world that had a scheduled football game with Memphis. I decided to take a chance.

I called the pilot: "Glenn, don't tell anyone I said so, but if I had to guess I'd say we were just about a minute away from Memphis and that it was just on our left. But don't quote me to the other planes."

Good old confident Glenn, however, immediately announced to the other planes that we would be over Memphis in exactly one minute just on our left. I guess he figured that since you couldn't see the ground anyhow it was a safe announcement. I felt terrible. We had about zero chance. I'd resign again. My name would be mud.

But darned if in exactly one minute there wasn't a break in the clouds, just on our left; and darned if there wasn't a big beautiful city; and darned if the other navigators didn't recognize it as Memphis. I had no idea what it was, myself.

When we got home I was a hero. I was Balboa, Columbus, Joe DiMaggio. I could do no wrong. I was a real navigator. I was famous in our group.

So, from that time on, I never paid any attention to where we flew. Why should I? I was a hero. I knew everything. My crew trusted me. I could play the radio.

Enter the Log

They have a nasty thing in AAF circles called a log. This is a standard form on which is recorded the history of each flight. The navigator theoreti - cally fills it in every few minutes, showing how fast he is flying, wind direction, where he is at that time, and what time he is expected to reach his destination. The expected time of arrival is abbre - viated as ETA, and is the sixty-four dollar question of every navigator. A good navigator is expected not only to reach his destination, but to reach it fairly close to his ETA. In my case, I never really cared about ETAs, being always thankful when we arrived in the right places in the first place, but still and all, they were good things and very important.

But about the log itself. The AAF certainly could have suffocated the Germans by dropping the wasted logs in Europe. We might have been without food, there were days when we lacked engines for our planes, but, by George, we always had plenty of logs. And the worst part, we were supposed to turn one in--complete in every detail--every time we left an airplane. They served as a check on the navigator.

In Navigation School it was easy. Three of us flew on every mission, one doing pilotage (looking at the ground), one dead reckoning (figuring it out from the log), and one celestial (the stars).

On these flights it was fairly easy to keep a log. The pilot knew where he was going and didn't have to bother you. And while two of the student navigators were usually lost, the good old pilotage navigator could usually manage to let you know where you were and you slipped that down on the log. Personally, when I was in that swaying plane, I couldn't work even the sextant I could see through. Yet I became very adept, upon being told where we were, at figuring the tables and putting the stars where they were supposed to be. I would then turn in my log. Although the methods for creating it were of no navigational value, the log looked okay--and I graduated from school.

All this time, of course, I was patiently trying to acquire a sextant I could see through. I don't know why, particularly, since the fact of the matter was that I couldn't work it anyhow, but I just felt a kind of personal grudge against the AAF for their snide ways. Every time we shifted closer to an overseas unit, I would rush to the supply officer, explain that I couldn't see through my A-10 sextant, and could I please have an A-12. The inevitable answer, "The next base." To this day I haven't reached that base.

Over Choppy Seas

When we finally took off for the flight over the Atlantic Ocean to Scotland, I still had the sextant I couldn't see through. It was in a nice wooden carrying case, and came in very handy as a chair. I never took it out of the box. This upset the crew somewhat, but I kept telling them about Memphis, and to my surprise we only missed the ETA into Scotland by two minutes--considerably better than par for the course.

Now, the average navigator thinks he's pretty smart. All right, maybe he isn't like me and he doesn't get lost in Central Park. So he flies along for a couple of hours following his flight plan, and he works his driftmeter or his sextant or his DR or his compass--anything but the radio--and he figures, "Ah hah, the wind has changed, the flight plan is wrong. I shall have to improve on it." And sometimes he's right. The wind does change. The sextant can be right. And he may be right.

But I suffered no such handicaps. I didn't have a workable sextant. Confidence, the driftmeter, and I were not on speaking terms. And the radio didn't work over the ocean.

So, I did an ingenious thing. I followed the flight plan exactly. We might have been drowned, we might have landed in Germany, we might have disappeared--but we didn't. We only missed the ETA by two minutes. It was superb navigation. My crew will swear today that I was the world's best navigator. I didn't deny it then. It's good for your crew to have confidence in you. I was a hero. The only thing was in spite of my wings, in spite of flying the ocean, in spite of my crew, I couldn't navigate worth a darn.

England was a grand country. I liked the land, the girls, the pubs, the girls, London, and the girls. They had a free and easy camaraderie. Maybe they only wanted to get married, to come to America, to have a candy bar, a piece of soap, a cigarette; but anyhow, they were real and they tried to be nice. We weren't freeing their country, or saving it; they could do that themselves. We were a bunch of guys with a few bucks and a devil-may-care attitude. We represented fun and escape. I liked them.

From a navigational standpoint, however, England was an awful place. Densely populated,

the countryside all looked the same from the air, and it was practically impossible to identify your position by pilotage. Everything looked the same. I was constantly being embarrassed.

Spelled Backwards--It's Still Radar

Along about this time we were exposed to radar. Radar is another clock-faced gadget on which land and cities appear as yellow, whereas water appears black. In other words, if you are flying over the coastline, you can identify it by its outline in yellow, and a city will show up as a bright yellow dot. This is all very well, if you are where you think you are in the first place and a dot shows up. You can announce: "This is London." But if you don't know where you are anyhow, one dot always looks pretty much like another dot, and when I proudly announced we were over some unknown dot, it aroused little enthusiasm among the crew.

Some of us were sent to a radar school. It was a fine assignment. It meant we could have two weeks leave in London before school started.

You may have guessed that I was kicked out of radar school. For a change I didn't have to resign. But interestingly, I wasn't kicked out for being unable to work the radar. I was kicked out for being unable to navigate. Period! For once everybody agreed. I was a failure. I was unable to do simple navigation over England. I felt terrible. I thought they would send me home. Instead, they sent me to a combat group and three days later I flew my first bombing mission over Germany.

Combat navigation in the 8th Air Force, I soon found out, had its advantages. You could drop bombs on the enemy. You could strike a blow for democracy. But who cares? These trivia were unimportant. The magnificent thing was, really, that in the 8th Air Force you didn't have to use the sextant. In fact, you didn't even have to navigate. All you had to do was follow the lead plane. Just like OTU. Follow the lead plane.

I had found my niche.

Combat sounded like fun.

On my first mission we bombed Aachen, a pleasant little town in the Ruhr Valley. By my standards, it was a highly successful mission. We hit the target and we got home safely. My navigation had been superb. I hadn't made a single mistake. I hadn't opened my mouth. I hadn't made an entry on my log. I had never known where we were. I had been lost the entire time. But we got home safely. The mission was successful. My crew had confidence in me. I had recognized the English Channel. We got home safely. We were in. We were Veterans. Navigation was easy. We were heroes.

In reviewing my Air Force career, it seems incredible that I ever became a lead navigator--the guy in front of those other 35 planes. I never wanted to be one. I knew I was the world's worst navigator. I knew that announcer in Memphis wouldn't show up over Berlin. I didn't like navigation. I didn't like airplanes. I couldn't understand what made them fly.

Still and all, everything went pretty smoothly for the next few missions. We would peacefully fly into formation and peacefully follow the guy ahead to Germany and back. Our plane was just like Mary's little lamb. It was a good arrangement. But on our seventh mission we ran into a little trouble. Our plane wouldn't work. It wouldn't leave the ground. It must have been psychic.

We felt pretty good about the whole thing. Our target that day was Merseberg, a place with more flak guns than anybody. It was a good day to stay home and play poker.

But the colonel felt differently about the matter. It seems they had extra planes for little emergencies of this kind. And he felt it would be nice if we could go along with the other fellows.

Firm Guidance

"Just intercept them along the coast," he said. Well, this was really something. Our group had been gone 30 minutes by this time. And all the colonel wanted us to do was intercept them along a vague coastline in a foreign country at an indefinite altitude at an uncertain time in a plane flying 200 miles an hour. The colonel's proposal made me laugh. It was practically an impossibility. Even a good navigator couldn't have done it.

I didn't even try. I just flew east and headed towards Germany. We tagged onto the first group of airplanes we could find in the sky. It turned out to be our own 8th Air Force. We breathed easier. We flew into position. It turned out to be our own group!

I told the crew it was luck. They wouldn't believe me. I told the colonel it was luck. He wouldn't believe me. Instead, they made me deputy lead navigator. I was again a hero.

On my first mission as deputy lead, everything had gone pretty smoothly. Our target was Berlin. We had found it. We were over it. We were about to drop our bombs. I might add that dropping the bombs was the high point of any mission. Not from a tactical standpoint. From a safety standpoint. Once you dropped your bombs you were much less of an explosive target. If a stray piece of flak hit the bomb bay, which was always likely, you wouldn't go up in a thousands pieces. You would just settle slowly, and maybe even have a chance to jump.

Well, there we were over Berlin and the bombs were about to be dropped. I was huddled over my flak suit, behind the bombardier, protected in two directions, patiently waiting to hear "bombs away." Then we would go home.

Finally I heard the magic words. The plane lightened. We started to turn towards home. I relaxed. I uncovered my eyes. I felt better.

The pilot screamed over the interphone, "Which way do we go?" What a dummy, I thought. "Follow the lead plane," I said. "It's just been shot down," he said. "Oh," I said. "Then follow the lead squadron.""We're the lead squadron," he said. I thought I could detect a certain impatience in his voice. We were still turning. I looked out the window. There was heavy flak to our left and heavier flak to our right. "Straighten out," I said "It's a short cut."

I felt like a guy who has just climbed the ladder of success, burned it triumphantly behind, and then discovered he has to climb down again to find the bathroom. Only no ladder.

We weren't outside the classroom in San Marcos. I couldn't copy someone else's log. There wasn't any lead plane to follow. I couldn't even resign. I was over Berlin, Germany; 1,000 miles from home and 34 airplanes were hanging on my vapor trails. The pilot wanted to know where to go. They were shooting at us. I was in the plane, too!

The day was gorgeous. You could see the countryside for miles and miles. The only thing was, it all looked the same to me. We flew straight. I quit looking at the ground. I looked in the air. Maybe, I thought, I can pick something out of it.

I did. In the distance, about 20 degrees left, flying confidently as carrier pigeons, were two other groups of planes. I assumed they were ours. They were heading away from Berlin. "Turn 20 degrees left," I said. "And step on the gas."

We followed the groups over Germany, we got to the Baltic Sea, we disappeared from the sight of land. I relaxed. No flak. We were going home.

You must understand that although I was the world's most hopeless navigator I never mentioned this to the crew. It wouldn't have done any good and might even have worried them needlessly. I never said, "Follow that plane," just "twenty degrees left."

Well, about this time I started fiddling with the gee box. This is a navigational aid which tells you exactly where you are when it tells you anything at all. It works over England, it works over occupied France, it works like the radio, wherever they have stations. But they hadn't sold the Germans on the idea. It didn't work near Berlin.

But, by George, it worked then, and for the only time in my combat career I knew for sure where we were. The gee box said we were over the Baltic Sea. I checked again. I looked out the window. Water. No question about it. I made an entry in my log.

And then for no reason I can think of, the two groups ahead of us turned a sharp left and headed straight for occupied France. Well, I can safely say, this was a problem. And not only mine. The pilot called me. He was a special pilot. He wasn't so dumb. "Those other groups are turning left," he said, "and I'm going to follow them."

Ten minutes earlier I would have commended his intelligence. Two hours earlier we had cemented ourselves to their tails. We might have been heading for Siberia. But we hadn't. We were over the Baltic Sea. And I knew it. I was sure. I would have bet my cigarette ration on it. I couldn't let him follow them. We would have been shot down.

"Listen," I said, "We won't follow anybody. What kind of a navigator do you think I am?" I was pretty hurt by his whole attitude. "Just keep going straight!"

He gave in. We watched the other groups disappear.

Tragically, to this day, I can't imagine where they went.

But we got home to England.

It was brilliant.

They promoted me to lead navigator. And I was again considered a hero. Do you think they could have been right?

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Challenges and Opportunities

General William V. McBride, USAF Retired

Remarks by then-Lieutenant General McBride at a Mather AFB Dining-in, 23 February 1973.

Tonight my comments will be primarily directed toward the student navigators--and the qualified navigators--in the audience. I hope the rest of you won't turn me off--but I am selecting the navigators as my target group because I was in your shoes some 30-odd years ago--as a student navigator--then as a working navigator. Quite frankly, I look back on those days with great fondness--some sentimentality--and an awful lot of personal satisfaction.

Why do I say that? Because it was a time of my life that I enjoyed immensely--in every imaginable way. I got satisfaction--because I was doing something I had always wanted to do--and doing it well enough to take pride in it. Perhaps that type of thought isn't as "cool" today as it was 30 years ago. But then again, I can't think of much today that resembles my world of that time.

As a matter of fact, my navigator training bears so little resemblance to yours that just about the only things apparently unchanged are the stars and planets we studied. Greenwich mean time and Polaris still appear to be pretty good standbys of the trade.

Compared to your navigation training program today, mine was a maverick experience, to say the least. I learned navigation as an aviation cadet with Pan American Airways --flying in seaplanes no less. I flew the Consolidated Commodores--a twin-engine flying boat. Ever hear of it?

All of my training was over water--mostly at night. The training was primarily celestial--with a very primitive sextant (I don't even remember the nomenclature)--a simple stove-pipe driftmeter--and a big D-4 aperiodic compass--so large you might expect to find one like it on the Queen Mary.

But I'm not going to spin a bunch of war stories for you this evening--although we might get into those later at the bar. I'm not even going to make these remarks lengthy. I don't like long speeches and I suspect you don't either. But if you have trouble stopping me tonight, it's because the subject is close to my heart and because I have much more than a ten-cent interest in navigators.

Let me just begin with this statement: I became a navigator because I asked for it. I'm still proud of that. When I came in as an aviation cadet, I took a series of tests--called Stanine tests. I scored fairly high in all categories. I saw that the criteria for navigators were higher than for pilots--and I decided I wanted to be the best--I wanted to be a navigator.

Of course, since then I have been able to acquire several additional ratings--but my first love was navigation--and I enjoyed every minute of it.

Matter of fact, as a navigator I progressed from a very young aviation cadet up to major when most of my pilot peers had not yet made captain. Of course, a lot of that was due to some factors beyond my control--not the least of which was some tough combat attrition.

But the point I want to make is that those early years were some of the finest of my life. I enjoyed them and I have no regrets. I am proud to say I am a navigator--that navigation was my first choice--and I want you to know it.

I am concerned, though, because I know that there is some bad-mouthing of the navigator business--some even from the navigators themselves and that irritates the hell out of me because it seems so symptomatic of professional naivete and unjustifiable career shortsightedness.

I'm not talking about the type of talk one might hear at the bar by a bunch of pilots trying to "prove" their superiority over all other living beings--particularly navigators. No--remarks of that type always rolled right off me. You know why? Because when I was a navigator I

knew that I knew my job better than they knew theirs--and I could do my job more effectively than they could do theirs --and they knew it too.

But I'm concerned about the prevalent belief in some navigator circles that I call "mythology of insufficiency" for lack of a better name. It is a mythology that is, unfortunately, somewhat encouraged by outdated attitudes based on misinformation and misconception.

I've little patience for the navigator who tells me he's got one hand tied behind his back--that he's in a dead end--that being a navigator is a career restriction. That's the cop-out of the century. I'm not saying there aren't problems or limitations, because there are. But they're problems that have to be met head-on, not head-in-sand.

Quite frankly, for too long a time there were too many navigators around who enjoyed getting their flying pay, but as soon as they got their minimum hours, they'd want to move to something else, and still get their flying pay.

I believe the Air Force tries very hard to provide career-broadening assignments and is evolving policy that will eventually open more options to more people--particularly navigators. But right now, the navigator per se is needed as a resource. This is a fact of life that will ultimately benefit the navigator career field.

A major point is that the navigator shouldn't be shortsighted at the temporary shortages that have arisen out of Southeast Asia--and the immediate needs that go along with it. When you think of a 20 or 30 year career, there are bound to be some force shortage actions that individual officers won't like. And while the Air Force finds such action sometimes necessary, believe me, it is not considered necessarily desirable.

The long range goal of the Air Force must be, of course, to develop the navigator resource to perform the primary mission. Elementary, perhaps, but absolutely necessary. Along with this objective, another long range, and equally important goal, is to have the opportunity for career-broadening assignments for navigators--within as well as outside the career field.

As it stands now, the Air Force says that navigators should expect to spend a good portion of their careers in the navigator career field and in other operationally-oriented areas. How much is a good portion? Well, they say a man who's out at 20 years might be flying more than half of his career. A man who sticks for 30 might find that percentage lower.

The navigator career field is in a constant state of flux--driven constantly by the evolution of technology. It's no longer a simple matter of being the guy who gets the aircraft from point A to point B. Multiple roles have developed and are developing--in the areas of sensors and countermeasures--all the current EWO development--more and more specialization exemplified by such courses as the six-month weapons system officer training in the F-4. All these point to the simple reality that, as increasingly sophisticated weapon systems are developed, the navigator plays an increasingly important role.

Look at the development of the T-43 and the UNT program here at Mather. The technological leaps represented by acquisition of these training systems do not bespeak a "dead end" to me.

The navigator finds his role expanding to other systems because of more sophisticated guidance and inertial systems that demand more and more navigational expertise. As this fact becomes better known and more widely experienced, I believe navigators will finally achieve a clearer perspective of their place in the scheme of things.

In the meantime, perhaps all of us have to shake out the cobwebs a bit and bring ourselves and our understanding of the world around us to date. You've got to understand there's more to being a navigator than navigating, just as there's more to being a pilot than piloting. You must remember you are an officer first.

Let me tell you what I, as a commander, am looking for today--and I think it is the same for all senior commanders. I'm looking for good managers for tough jobs--and I have trouble finding them. I am looking for leaders--officers who want to work hard--officers who want to make a contribution--officers who seek responsibility.

The important jobs today are probably tougher than they were 30 years ago. But the guy who wants to do more than is expected of him has a greater opportunity today than he did 20 or 30 years ago. Believe me, when I'm looking for a good man to fill a tough job that has bent or broken another man, I'm not concerned about whether the right man is wearing pilot or navigator wings.

Performance is the criteria. Tough problems can only be solved by competent people--dedicated people--totally involved people--people who are more concerned about the quality of their craftmanship or professionalism than the shape or design of their wings. No matter what job an individual is given, the best chance for him to succeed and to progress lies with his willingness to do the very best he is able--in whatever job.

If he's a navigator or a pilot, he should strive for every opportunity to gain flying experience--to seek excellence in his specialty--to be the finest in his squadron--and then his wing. If he is satisfied with mediocrity--he must expect mediocre assignments and mediocre progress.

He should also strive for every opportunity to develop those subtle arts and skills of leadership and management that depend so heavily on the ability to motivate and activate other human beings and, yes, motivate himself.

Summing up, gentlemen, there are so many challenges out there for you--so many opportunities for you to contribute, and grow, at so many levels--that I honestly envy you the chance! How I'd like to be in your shoes!

Don't fall victim to what I call the "mythology of insufficiency." Don't start believing your own propaganda. It can only lead to disenchantment, disappointment and disillusionment. You have no room for that in your life. There is too much to be done, and far too little time to do it.

I thank you for inviting me to be with you tonight. I thank you for your courtesy and hospitality.

A Nav Heritage: The B-47

Major Walter W. Woodruff
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Thirty years ago, one of the most popular assignments from nav school was to an airplane that is just a hazy memory today. Few people realize that the Boeing B-47 Stratojet was an extremely important part of the US strategic arsenal in the 1950s and early 60s, and was built in larger numbers than any bomber since the B-29. Navigators were the key to the airplane's success; at one time literally thousands of B-47 navs were involved in making the Stratojet the primary weapon of the Strategic Air Command.

The origins of the B-47 go back to World War II, when it became apparent that jet engines offered a fantastic advantage over the reciprocating engines then at their peak of development. Toward the later stages of World War II, a number of prototype jet bomber designs were commissioned including the B-45, B-46, B-47, and B-48. All were powered by early, first generation engines, and all showed promising performance that greatly surpassed the contemporary B-29.

Of the bomber designs evaluated by the Air Force, the Boeing B-47 was by far the most advanced and sophisticated. It was the only aircraft to feature swept back wings, and offered a rather unusual arrangement of six jet engines suspended under the wings, a bicycle-type landing gear, bubble canopy, and provisions for jet-assisted-take-off (JATO). The B-47 offered phenomenal performance, and could outperform many contemporary fighters.

Rolled out of the factory in 1947, the B-47's first flight occurred on December 17, 1947; the 46th anniversary of the Wright Brothers' flight. The performance of such a large jet bomber was unbelievable at the time. One of the fastest airplanes in the world, the B-47 quickly proved its abilities by setting a coast-to-coast speed record of 3 hours 46 minutes. SAC was quick to see the potential in this airplane, and ordered it into production as a medium bomber. Although plans were underway for a bigger bomber with longer range, the '47 was available and could get into service faster than any other airplane. The bomber on the drawing board was, of course, the B-52, but that is another story.

One of the most radical features of the B-47, aside from its looks and performance, was its crew complement. The '47 was flown by three men: pilot, copilot and nav. The navs in those days were actually called radar observers, and the observer in the '47 had his hands full performing the role of the nav and radar nav with relatively primitive equipment. SAC's largest bomber, the B-36, had a crew that ranged in size up to 16, and the B-52 had 6, so the three guys in the '47 were busy. More on that in a moment.

Where could you be stationed with a B-47 assignment? Well, a lot of airplanes meant a lot of bases--some of which no longer exist. At its peak in 1958, B-47s equipped 28 SAC bomb wings and 4 SAC recon wings. The bases one could be assigned to were Forbes, Lake Charles, Altus, Lincoln, Barksdale, Bunker Hill (now Grissom), MacDill, Pinecastle (later named McCoy), Whiteman, Homestead, McConnell, Hunter, Smoky Hill (Schilling), Pease, Lockborne (Rickenbacker), Mountain Home, March, Davis-Monthan, Castle, Dyess, Biggs, or Little Rock. Quite a list! In addition, TDYs to overseas locations were not uncommon, and there were "Reflex" bases in England, Spain and North Africa, where B-47s were maintained. "Reflex" was a pretty good deal for '47 crews, for they would typically spend a week on alert, have a week off (during which time they could travel around Europe on military air flights), and the final week was spent back on alert. After a three-week TDY, they would fly their B-47 back home. The week off in the middle was the highlight of a Reflex, and most crews took full advantage of it.

What was it like to fly the '47? As previously mentioned, with only one nav it could be pretty hectic, requiring a lot of operator input and attention. The nav gear consisted primarily of

first generation mechanical computers and radar, largely the old "K" system. Long range missions were usually DR exercises backed up with celestial. Very few B-47s had Doppler, and the DR computer was just an air position indicator, but it was the best equipment available at the time. Terrain avoidance radar, inertial, FLIR, LLTV, SRAMs, and ALCMs were all in the distant future.

During the early '50s, B-47 crews helped pioneer several new techniques. Some of these were developed along with the airplane, so things got pretty interesting. For example, several brave '47 crews pioneered high-speed low level flight. Their basic rules were "Don't fly higher than 500 feet nor faster than 425 knots." The nav was *very* busy on these flights, especially with the non-automatic equipment at his disposal. Another technique was called the low altitude bombing system (LABS), where the '47 would roar along at low level, pull up into a steep climb as it approached the target, release the weapon at the top of a half loop, roll out wings level, and dive away. Unfortunately, this put a tremendous strain on the wings, and a number of airplanes were lost before LABS was abandoned.

Despite a number of difficulties associated with introducing such a new and radically different airplane in a short time, the B-47 quickly proved its worth. A B-47 crew from March AFB won the 1955 SAC bombing competition, besting the old pros in the giant B-36s. Since the '47 was over twice as fast as the '36, and carried about one-fifth the crew members, this was quite a feat.

The Stratojet was classified as a medium bomber, and because the early generation jet engines were very fuel thirsty, the B-47 relied heavily on aerial refueling. It was the first jet bomber to routinely use aerial refueling as a part of the mission, and by doing so, the '47 crews developed and refined many of the techniques used today. Most of the refuelings were done with KC-97 piston-engined tankers, which could barely struggle up to 18,000 feet when loaded. The '47s had to descend from their cruising altitude of 35-40,000 feet, slow down to refueling speed, hang on the tanker (which had everything open but the kitchen sink to keep up with the B-47's minimum refueling speed), and then climb back up to altitude; a very inefficient process. Many times as the '47 took on gas and got heavier, both airplanes would have to enter a shallow dive so the tanker could match the B-47s speed.

As it matured in service with SAC, more and more demands were placed on the airplane and crews. The gross weight, which was 125,000 pounds in the prototype, climbed to 225,000 pounds, while the engines remained relatively primitive J-47s, with only 7500 pounds of thrust. Losing an engine at takeoff was quite serious, especially an outboard engine, but overall the B-47 had a good safety record. The professionalism and dedication of the crews made the difference in many marginal cases.

The B-47s were phased out of service by the mid- 1960s. Some crew members were not at all sorry to see them go, but many thought that with modifications the B-47 could have been used up into the 1970s, especially as a high altitude bomber in Southeast Asia. Everyone agreed, however, that it was an excellent assignment for a navigator, that the nav could make or break a crew's success on bomb runs, low altitude runs, or even the Bomb Competition. The B-47 will be remembered as a true pioneer, and the knowledge gained during its years of service enhances present and even future generation bombers.

A graduate of North Carolina State University in 1973, Maj Woodruff completed UNT in 1973. He was then assigned to the C-130 at Little Rock AFB until reassigned to Mather AFB in 1978. From 1980-1982, he was the Editor of THE NAVIGATOR magazine. Next came duty at Little Rock as an instructor and navigator training program manager. Maj Woodruff now serves as a B-52 WST Program Manager at Wright-Patterson AFB.

In May 1983, then-Lieutenant Colonel Charles B. DeBellevue visited Mather AFB to address personnel of the 455th Flying Training Squadron. During that visit, the editor interviewed Colonel DeBellevue who, as an F-4 weapon systems officer, scored six MiG kills in Southeast Asia, making him the leading ace of the Vietnam conflict.

ACE NAVIGATOR

an interview with Colonel Chuck DeBellevue

THE NAVIGATOR: In reviewing accounts of your combat engagements, I noted that the 8 Jul 72 dogfight seemed extremely dramatic and exciting. You downed two MiG-21s. Which kills were those?

COLONEL DEBELLEVUE: That was a flight of two—my second and third kills. Yes, they were exciting. We were the egress CAP, the rear guard for the strike that day. Our orbit point was about 70 miles west of Hanoi. Two aircraft in the Hanoi area, an F-4 and an F-105, had engine fires and egressed from the area. Hearing their radio calls, we thought it would be a good idea to head east. As we turned, our radar controllers started calling blue bandits, MiG-21s arcing around Hanoi from the east. Suddenly, the controllers told us that we were merged. For two minutes no one saw the MiGs. Then, at eleven o'clock and just to the left of the nose, I spotted a black flyspeck against a white cloud. We turned to meet him head on. A few seconds later we were line, abreast with a MiG-21 going in the opposite direction. Ninety seconds and three AIM-7s later, after a hard turning fight, two MiG-21s were destroyed. Those kills were exciting because the distances involved were close, the speeds were fast—a lot of Gs—and quick decisions were required to get the job done. Looking back, every engagement was exciting—my adrenalin was always way up. In a crisis situation, like air combat, you do well or you fail—there's no in-between. You come out first or you don't go home. The adrenalin is so high that it's really hard to measure the level of excitement. When you're in there doing your thing, everything is habit patterns and memory—checklists. There's no extraneous talking going on—it's all very short and to the point. The job is to get the other guy and then get out. You can't afford to hang around. We never went anywhere straight and level—we always kept the airplane moving. The worst place to have an enemy aircraft is behind you because that's where you can't see him. Smoke trails always were a big problem. Our engines put out a lot of smoke. All an enemy had to do was find a smoke trail, follow it, and we were at the end of it. If we didn't move the airplane around and check our six o'clock, we might have been a fireball.

Lt Cmdr Duke Cunningham was the first SEA Navy ace in the F-4. He said that it is one of the most honest airplanes in the world. How do you react to that statement?

Well, not having flown anything but an F-4, and, of course, the various models each handle a little differently, I'd say the F-4 is very honest. It talks to you. If you're doing something it doesn't want to do, it will let you know. Now, you can press the issue and keep going with it—in which case the airplane will

The AIM-9 will turn inside a dime and give change.

pretty much take over—go out of control or whatever. But before you lose control, it will talk to you. The wings will start rocking or, in the D model, which is what we flew in SEA, once you reach a regime approaching the limits of maximum performance, you can't see the instrument panel because the airplane is vibrating and shuddering so much. It's talking to you. If you know how to fly it, you'll ease off

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a little bit—no big deal. It's when you don't listen to the airplane that you get into trouble. The newer models have leading edge slats to smooth things out—those birds don't tell you quite as much but they will still talk to you. It's how well you interpret these inputs that determines how well you fly the airplane. Some guys pick up on that real quick and some don't. I've always been fond of the F-4. It's an honest airplane.

To follow up on that—you were credited with two MiG-19 kills. I've read that the F-4 is much more controllable in combat than the MiG-19. Did you observe that to be the case?

We were told that the MiG-19 was a very hard airplane to fight because we couldn't outturn it. Supposedly, only an F-86 with maneuvering slats and an afterburner could outturn the MiG-19. I was flying an F-4D—not anything close to that. The MiG-19s were good. In fact, we were told that North Vietnam's better pilots flew them. On one of my engagements, we were heading out and had to run through two MiG-19s. We chose to fight them because there was no way to simply shoot through. They would have turned and run us down. We would have run out of gas trying to turn away from them, so we had to neutralize that threat. One fact saved us—we saw them first. We had 90 degrees of turn on them when they saw us. We knew they had spotted us because they jettisoned their wing tanks to get down to fighting weight. We were already clean, having gotten rid of our tanks prior to an earlier fight. We ended up behind them—not where they wanted us to be. We were armed with AIM-9 sidewinders (heat seekers)—very deadly missiles. The AIM-9 will turn inside a dime and give change. We fired two at the trailer and he left the flight burning. We fired another at the lead guy. That missile impacted the afterburner. The pilot had a chance to bail out. However, he continued on for a few seconds, straight and level, and then rolled inverted and impacted the ground. In recording my six MiG kills, two of them were single kills and two were double.

How many of your kills were with Steve Ritchie?

Four were with Ritchie—the MiG-21s. The two MiG-19s were with John Madden who scored three kills while in Southeast Asia.

From your limited experience in the F-15, can you draw any comparisons between it and the F-4?

Well, the F-4 is a big airplane. It hauls a lot, carries a lot of missiles and has a gun on the E model. It has a lot of capability. The F-15 is built by the same company. It hauls basically the same munitions—four AIM-7s, four AIM-9s and a gun. It is also a big airplane. It gets the job done. Now, if you take the airplane out of the picture, you must consider the men flying it—operating that system. When I go up against another airplane I'm not going up against just the airplane or just the crew. I'm going up against the entire system. It is how well I fly my airplane against how well an enemy flies his airplane that counts. The other guy can be a better flyer in a better weapon system but it's how well I do against him on that particular day. Of course, I always want to be in tiptop shape to get the job done. Second place can be fatal. By knowing the enemy's airplane and capability, you may be able to change your tactics to put him at a disadvantage.

I read that aerial tactics are strictly a game of relative motion and time and distance problems. Do you agree with that statement?

Aerial combat is a very fluid situation. I have to get my airplane a certain distance from the enemy's and within certain parameters if I'm going to employ an AIM-9 or AIM-7. Meeting the parameters involves time and distance. If I don't project his flight path or if I fail to position my airplane relative to his path, when I'm ready to fire, I may not be able to take a shot. The game is constant motion. You must continuously project yourself ahead. What's that guy going to do now? What is his best shot? What is my best shot? Where is he headed? I must maneuver my airplane to gain position by anticipating his action. If he counters my move, then I must change tactics. The guy who can do that best wins. It boils down to action and reaction.

Fighter guys constantly talk about "energy." What does that mean and how does it relate to aerial combat?

The concept of aircraft energy is very important. We're concerned with two types of energy—kinetic and potential. If I'm down low, I want to have a lot of kinetic energy—I want to

be fast. An F-4—or any airplane—turns best at a specific speed based on its weight and the shape of its airfoil. There is a certain airspeed—we call it corner velocity. If you're at that speed you can make your quickest, tightest turn. That's kinetic energy—airspeed. If I'm high, by virtue of that fact, I have a lot of potential energy which I can convert to airspeed. In the F-4, we use the vertical factor a lot. Fast down low allows the F-4 to zoom in the vertical. As the airspeed decreases, by putting

...given a choice between being good and being lucky, I'd probably rather be lucky.

the aircraft on its back and using the force of gravity—God's G—to help, a very tight turn can be made. Going downhill, I accelerate better. Energy management dictates how well you may do in air combat. When low and slow, I've got to use brute force to regain airspeed. The F-4 is a brute force airplane but it accelerates even better going downhill. We did a lot of fighting against the MiG-21, a very sleek airplane. It could accelerate down low a lot better than we could and it could maneuver slower—it had that slight advantage on us. How one manages energy can greatly influence the outcome of a combat engagement.

In THUD RIDGE, Col Broughton mentions superstitious habits that take root during combat duty—as a flyer approaches number 100, the magic mission—such habits as not changing your flight suit or your underwear, or gloves, or other things like that. You logged 220 combat missions. What superstitious habits did you practice?

The magic 100th mission didn't apply to us as it did with guys who flew in Rolling Thunder, the strikes into Route Pack VI during the 67-68 timeframe. They needed 100 missions to go home. We had no such quota. Many of us logged more than 100 missions in the north. I flew 96—several guys flew 150. We weren't in the same situation as Col Broughton, but the superstitions were still there. A new pair of gloves can't fly an airplane. I needed an old set. Or, to break in a new set, I had to fly a very low demanding mission so that the gloves would learn. We did everything in the same way. The helmet stayed the same—I didn't change anything. My present squadron, the 335 TFS, was one of the original RAF Eagle squadrons in WWII. In our squadron building, we have pictures of some of the aces from the original squadron. One photo shows a young pilot sitting in his airplane holding a teddy bear. I imagine he wouldn't have flown that day without that teddy bear. In SEA, some guys flew with lucky charms. I didn't have any, per se, but I wore the same outfit every day—I tried to follow the same routine.

Did you follow some special practice prior to a mission, such as eating certain food, or putting your left boot on before the right?

No, nothing like that, but we did go through a procedure that got us ready for each mission. Everybody was scared but it wasn't the type of fear that impairs your performance. It probably helps. I hated flying with new guys. Often, returning to PAC 6 with a veteran was safer than a training mission with a new guy. (The northern part of Vietnam was divided into two sections. PAC 6 BRAVO was an area from east of Hanoi to the west. The Air Force worked that area. The Navy worked their strikes in

For a new guy to get ready, he must think, "Hey, I'm the best WSO in the world. I'm the guy that's going to get the job done."

PAC 6 ALPHA which was the area around Haiphong harbor.) I think everyone was a little superstitious. A friend of mine was shot down during our last mission. He was picked up right away. Upon his return to the base, the guy took a stuffed alligator he had been carrying for good luck and burned it—the luck had run out. You might say that if you know what you're doing, you don't need superstitions or luck. Well, maybe so, but given a choice between being good and being lucky, I'd probably rather be lucky. A combination of both is best. While in SEA, we were visited by a man from the Air University who was writing an article on the superstitions of fighter jocks. He interviewed us and specifically one flier who had collected idols and symbols from every conceivable religion. This guy always went into combat chanting a jingle he made up, just in case he got shot down. He planned to say, 'Hey look, I've got one. I'm one of you.'

If I were a young WSO scheduled to go into aerial combat tomorrow morning, what would

be the most important thing you could tell me about going out to do a job I've never done before?

First, you must know yourself. Second, you must know your weapon system—especially in a demanding mission like patrol of PAC 6. Whether your job is to drop bombs or fight air-to-air, the eve of your first combat mission is not the time to learn. If you haven't studied prior to the night before, then it's too late to polish your act. You should know exactly what's going on. If you're the lead backseater, it's your job to navigate into the area. As a WSO, you're not just a copilot, navigator, or bombardier; you're all of them. You do many things. We flew four hour air-to-air missions. During each of them, we had at least one air refueling into the target area—maybe one coming back—and we also had about 20 minutes on station. The backseater was as responsible for the success of each mission as the frontseater. We felt we could do anything the pilots could do. Pilots trained their backseaters because they knew so much depended upon them—they had to know what was going on. For a new guy to get ready, he must think, "Hey, I'm the best WSO in the world. I'm the guy that's going to get the job done." I knew my weapon system cold. Everything, from the radar down, was committed to memory. A lot of self preparation was required. During the big missions up north, much of our preparation was getting 'up' for the flight, because there was a good chance that you might not come home. That didn't play in one of my missions; I wouldn't let it, but I was ready. My roommate got shot down during one of our missions. That's really eye-watering. Flying combat in a fighter is not quite like fighting in the infantry where you live with it and are in the same foxhole, shoulder-to-shoulder, for days at a time. After combat, at Udorn, we could at least get a chance to relax until the next day's mission. But then your buddy goes down and it makes you stop and think. It brings reality right up to your nose.

During combat engagements...you're constantly doing what it takes. You end up with a neck that is a couple of sizes larger.

How stressful is the combat environment?

You are under a great deal of stress. During combat engagements we didn't feel any Gs. The adrenalin was so high that we hardly felt anything. You're constantly doing what it takes. You end up with a neck that is a couple of sizes larger. If you need to look at the radarscope, while you're pulling six Gs, you look at the radarscope. If it's time to look behind you, then you do that. You have to stay loose. If you don't, you can pull a muscle. But you adjust to that stressful environment. The first time you go out on a six-hour combat mission, you come back whipped. Eventually you get used to it. You're still tired, but it's not as bad. In fact, when you score a kill, the adrenalin is pumping so much that two days later you still haven't landed—it's a natural high. Some guys drank heavily in SEA. I used to have a bar bill that ran over $100 per month from buying drinks for the bar when I got a kill. Since drinks were only 25 cents, that's considerable. However, no one could afford to fly without everything going for him. It took 110% to get the job done.

Well, let's change the scenery and bring you out of the combat environment and back to Mather. You graduated from navigator training in 1969. Now you're seeing Mather training in 1983. How do you view the changes you've seen?

When I went through navigator training most instructors had little fighter experience. I had no idea of what fighters would involve. In that respect, training today is much better. The program now gives students a chance to understand what is happening at a slower pace than the F-4 travels. At 200 mph in a T-37, things are easier to manage than at 420 or 480 in an F-4. The Tweet lets students start out slow, and then speed up. RTU was also different back then. For intercepts, we probably had a better training program than today's students do—ours was more specialized When I went through RTU, we had six weeks of radar training. It was just navigator instructors out of ADC—F-101 navs teaching us how to run intercepts, operate the radar, and things like that. We didn't fly initially. Six weeks after our arrival the pilots arrived and we started the flying portion. In those days, pilots flew as backseaters. I was in one of the first classes of navigator backseaters. Most of the frontseaters in the RTU classes were backseat pilots moving up to

the front seat. The academic program was not highly structured—instructions came mostly from the guy you crewed with. He would teach you his techniques. I think today's student is much better prepared to go into fighters when he leaves Mather. Of course, the first experience in the F-4 is a terrific learning situation too. A new backseater starts off expecting someone to look over his shoulder and say "yea" or "nay." Very shortly he's going to find out that there's no such thing in the fighter business. He's on his own. He'll go with an IP for a couple of rides, probably be assigned to a more experienced AC in the squadron, but soon he'll be with one of the newer aircraft commanders. All of a sudden, he must know what is going on. It is up to him.

As a backseater, if I flew with a new AC, I had to know the front seat as well as the back seat, since our airplanes were often strangely configured due to battle-damage repairs.

That leads me to the inevitable question. In 1982, you were reassigned to the **335th** *at Seymour Johnson as a lieutenant colonel pilot. You returned to that squadron that you originally joined as a first lieutenant WSO in 1970. Would you comment on the two different experiences?*

Of course, the 12 years between assignments have made a big difference. When I came out of RTU, as a navigator assigned to the **335th,** I knew the airplane and the job, but I was still searching. My confidence level was not very high. I could work everything, but I was unsure of my ability. The experience that followed taught me what flying fighters is all about. We flew the airplane and got the job done. When I returned to the **335th** as a lieutenant colonel, it was the same squadron—moved to a new building—and I found that the people are just as conscientious about flying and making sure the job gets done. I think we do more now—at least from what I remember. It seems that the unit is tasked with more and the personnel are required to do more. I'm very impressed with the job we do.

Having been a WSO and fought in combat, do you feel any unusual affinity toward WSOs that perhaps other pilots don't share?

I can tell right off whether or not a WSO is doing his job. Before I left the backseat, I had done virtually everything an F-4 could do. In combat, I participated in bombing raids, air-to-air fights, forward air-controller missions—everything. As a backseater, if I flew with a new AC, I had to know the front seat as well as the back seat, since our airplanes were often strangely configured due to battle-damage repairs. It helped if a WSO could talk his frontseater around the cockpit, if needed. When I switched to the front seat, one advantage was knowing the back. After being in the front seat a while, I could go up with a young backseater and say, "OK, here's what you're going to do." On an intercept ride, for instance, the radar not only sweeps right and left, but the tilt can be adjusted up and down. It depends on where you aim the radar as to when you see the target. If the backseater can't see the target, he may start adjusting the radar tilt faster than necessary. I would often see the target before he did. With my experience, I can talk to a rookie WSO and help him out. On the other hand, I'm probably also extra critical because I know what can be done in the rear seat. When I was a backseater, I never thought of myself as a second-class citizen. Any job is what you make of it. We are all part of the same team. As you know, there are many navigator jokes and pilot jokes. I've heard the best and worst of both. As a pilot, I don't treat fliers differently. I judge others not by their wings, but what they demonstrate to me.

Is there any reluctance from WSOs to fly with you because of your unique experience and extra-critical nature?

I don't think so. They may be reluctant to fly with me at first because they're not sure of where I'm coming from. My reputation as an ace preceeds me everywhere I go. Guys are usually in awe of that. However, I think I'm pretty down to earth. I tend not to let what's happened get in the way of things. People can fall back on their laurels only so much. It's nice to face an audience and talk about history and tell war stories—we all enjoy that. But there is a job to do. I'm not ready to be put out to pasture—I still want to do my share.

What attributes are necessary to be a good WSO?

Know your airplane—that means studying the books. If you don't know your job cold, you're wasting someone's time as well as your own. Know yourself. That will become particularly important in combat. What are your limits? Not everyone has the same limits. Some pilots and WSOs can fly the airplane with their eyes closed while others have to work at it. There is no room in the airplane for a passenger—you are part of the crew. If the airplane misses a target, whose fault is it? Well, it is 50% the backseater and 50% the frontseater. It is not just one fellow's fault, but the crew's fault. In 1972, the Navy conducted a test to determine the best experience combination for a front and backseat team. They combined a highly qualified frontseater with a highly qualified backseater—an excellent crew. A mediocre frontseater with a top-notch backseater made a better crew than an outstanding frontseater with an average backseater, according to the Navy's test. I have found their results to be true. A good WSO must also be directive—he must be assertive. In my opinion, the pilot probably should be a shade more aggressive than the backseater, if for no other reason than his requirement to occasionally say, "Hey, have you checked this yet?" You really can't compare the crew concept in the F-4 with that in the bomber, or tanker, or transport. The fighter has two fellows tasked with a very demanding job—not a static condition but one that is constantly changing.

Sometimes a situation reverts to eyeball against eyeball. That's when the twoseater can really pay off.

What do you see as the future of the two-seat fighter?

A two-seater offers several advantages. It is easier to get the job done with a two-place airplane. There are two people to concentrate on the mission. I would like to see another two-seat airplane come down, and I think there will be one. Two people offer much broader capability in a wider variety of missions. You don't need two seats in every situation, but two seats offer a definite advantage in certain cases. An extra set of eyeballs always comes in handy. The frontseater can't look everywhere. Once in a while our "magic" radar malfunctions. Sometimes a situation reverts to eyeball against eyeball. That's when the two-seater can really pay off.

The World War II-Korea American Fighter Aces book contains a photo of a 1967 American Fighter Aces Convention. Since you are a fighter ace, have you ever been invited to one of those conventions?

I attended one right after Southeast Asia, in San Antonio, in 1972. The group is becoming rather small.

Who keeps the official records on the score for awarding the title of aerial combat ace?

The title is awarded after five kills. Once you shoot down an airplane, you submit a claim which has to be substantiated. In my case, the rest of the flight was able to substantiate most of the kills. Official Air Force orders are then issued awarding you a kill. The same procedure applies for the Navy and other military branches.

Do you have any final comments for our readers?

Flying a fighter is quite different from flying other types of airplanes. The sum total of all your efforts is to be ready to go to war. Not that you ever will, but if you are ever called upon to defend your country, you must be ready. Whether you are a backseater or a frontseater, readiness is essential. You never know when the call will come. It may be a phone call in the middle of the night. There is little time to prepare after that. You must be up to speed all of the time. In war, you either finish first or you lose. It is up to you to make sure that you come in first. Patton summed it up when he said, "Dying for your country will not win a war." Our constant readiness is our strongest deterrent against war. We're not a war-mongering country. We prefer to let others live as they choose. But, no one should tell us how to live. This country was created by people seeking freedom—who were willing to risk their lives to preserve that freedom. That commitment is our heritage. It is up to us to preserve that heritage for our children and their children. We must strive not to cause war but to prevent it.

Thank you for sharing your views and experiences with us.

STAR IDENTIFICATION

Reprinted from the Spring 1982 issue

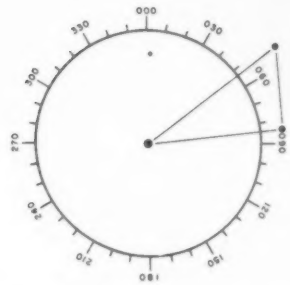
Editor's Note: These are the remaining 25 stars promised in our Summer 1986 issue.

Each chart shows the first, second, third, and fourth magnitude stars that are visible when the desired star is "centered" in a sextant with a 15° field of view. Lines are included to make the patterns more meaningful. The stars are shown as they would appear from the North Pole. For other latitudes, the accompanying tables of position angles tell how much the charts should be rotated to give the positioning relationship for the time of the observation. Dashes are used to indicate that the star is below the horizon.

To use the charts, enter the tables with the closest values of latitude and LHA of Aries to find the position angle. (Though interpolation can be used, it is not usually necessary to do so.) Then rotate the chart until the position angle is at the top; the star pattern that results is the one that will appear in the sextant.

Say, for example, that you want to shoot Menkar and your latitude is 33N and the LHA of Aries is 114. Using 30N and 120 will give you a position angle of 300. Rotate the Menkar chart so that 300 is at the top. With Menkar centered in the field of vision, you will find the identifying "parallelogram" pattern extending to the right.

DENEBOLA



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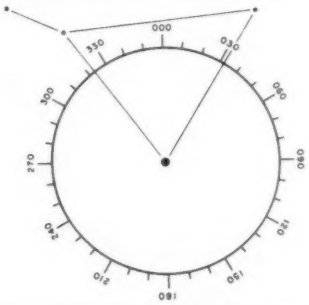

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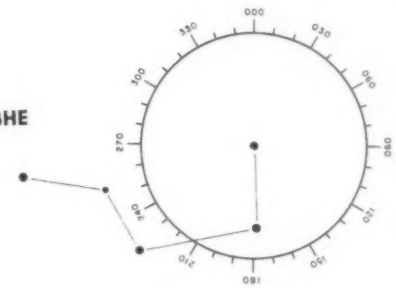

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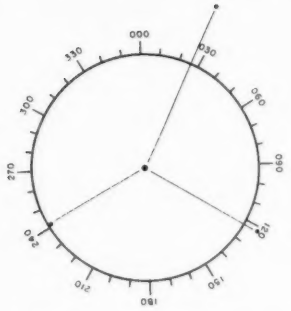

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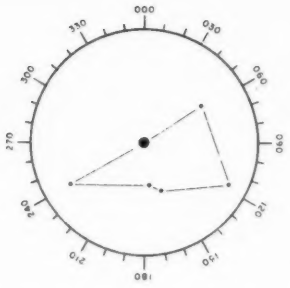
FOMALHAUT



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40S	228	242	238	228	-	-	-	-	131	121	118	135
50S	207	227	227	219	-	-	-	152	140	133	134	157
60S	195	212	215	211	201	187	172	159	149	145	148	166
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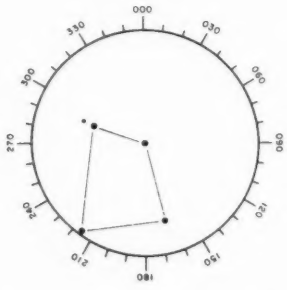
GIENAH



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40S	-	-	-	129	126	135	172	220	233	232	-	-
50S	-	-	-	139	138	147	175	207	221	222	-	-
60S	-	-	156	149	149	158	177	198	209	212	207	-
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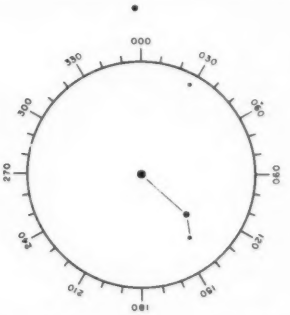
HAMAL



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20S	142	177	215	237	-	-	-	-	-	-	-	121
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60S	166	179	192	-	-	-	-	-	-	-	-	-
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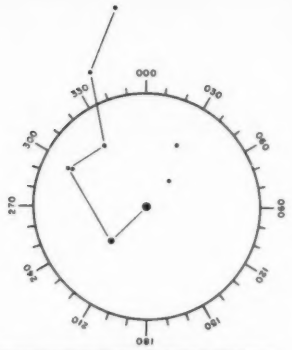

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20S	-	-	-	-	-	-	-	-	-	-	-	-
30S	-	-	-	-	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
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60S	-	-	-	-	-	-	-	-	-	-	-	-
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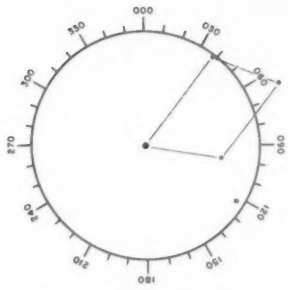

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40N	043	020	343	319	311	-	-	-	-	-	-	050
30N	054	029	334	307	300	-	-	-	-	-	-	060
20N	066	043	320	294	290	-	-	-	-	-	-	071
10N	080	068	294	280	279	-	-	-	-	-	-	081
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20S	119	147	209	240	248	-	-	-	-	-	-	111
30S	131	157	200	228	238	-	-	-	-	-	-	121
40S	141	163	195	218	228	-	-	-	-	-	-	132
50S	150	168	191	209	219	-	-	-	-	-	-	141
60S	158	171	188	201	208	-	-	-	-	-	-	151
70S	165	174	185	194	199	-	-	-	-	-	-	161
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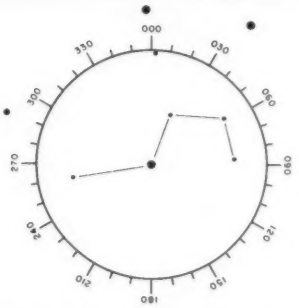

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60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
30N	-	-	-	-	-	-	-	-	-	-	-	-
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0	-	-	079	049	019	347	316	287	-	-	-	-
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30S	143	117	090	060	024	344	307	275	248	222	196	170
40S	146	121	095	066	027	342	302	270	244	219	195	170
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60S	152	132	112	087	046	328	279	253	231	211	192	172
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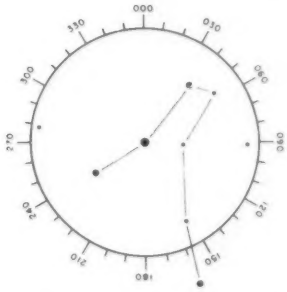

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10S	129	158	191	222	248	-	-	-	-	-	-	-
20S	134	160	190	219	-	-	-	-	-	-	-	-
30S	-	163	189	214	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
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80S	-	-	-	-	-	-	-	-	-	-	-	-

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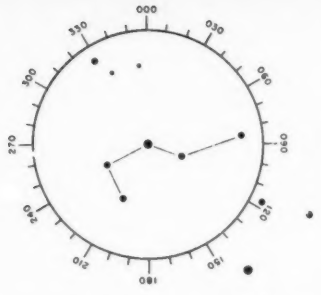

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50S	225	219	-	-	-	-	141	134	137	159	203	223
60S	214	210	201	-	-	159	149	146	151	168	193	210
70S	202	200	194	185	174	165	160	158	162	174	188	198
80S	191	190	187	183	177	173	170	169	172	177	184	188

PEACOCK

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
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20N	311	-	-	-	-	-	-	-	-	034	006	337
10N	306	-	-	-	-	-	-	-	065	038	006	334
0	301	275	-	-	-	-	-	-	070	041	008	332
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40S	271	249	229	207	185	161	140	119	098	071	016	305
50S	258	240	222	204	184	164	144	128	109	090	033	282
60S	240	229	215	200	184	167	151	136	125	116	144	243
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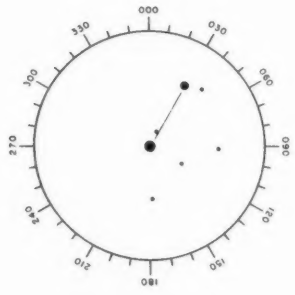
POLLUX



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10N	-	083	097	122	193	248	267	280	-	-	-	-
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20S	-	-	125	149	185	218	240	-	-	-	-	-
30S	-	-	133	155	184	212	231	-	-	-	-	-
40S	-	-	141	160	184	207	223	-	-	-	-	-
50S	-	-	-	163	183	201	-	-	-	-	-	-
60S	-	-	-	-	182	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
90S	-	-	-	-	-	-	-	-	-	-	-	-

PROCYON

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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10S	-	101	106	123	201	246	257	-	-	-	-	-
20S	-	110	118	139	193	233	246	-	-	-	-	-
30S	-	120	128	149	188	222	236	-	-	-	-	-
40S	-	130	138	157	186	212	226	-	-	-	-	-
50S	-	-	147	162	185	205	217	-	-	-	-	-
60S	-	-	155	168	183	198	208	-	-	-	-	-
70S	-	-	164	172	182	192	198	-	-	-	-	-
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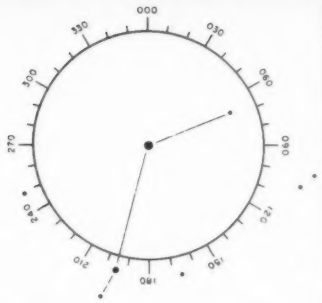
RASALHAGUE



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30S	-	-	-	-	-	-	-	130	152	187	219	235
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50S	-	-	-	-	-	-	-	148	164	184	204	216
60S	-	-	-	-	-	-	-	156	168	183	198	207
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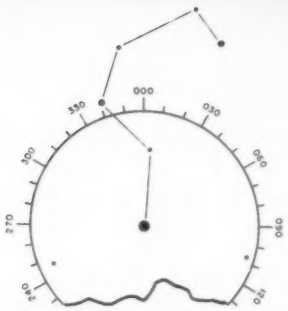
REGULUS



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30N	-	-	060	062	054	006	309	298	299	-	-	-
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10N	-	-	080	085	091	136	269	274	279	-	-	-
0	-	-	-	096	108	171	249	262	270	-	-	-
10S	-	-	-	107	124	175	233	252	260	-	-	-
20S	-	-	-	117	135	176	221	242	-	-	-	-
30S	-	-	-	127	145	177	212	232	-	-	-	-
40S	-	-	-	136	152	178	205	223	-	-	-	-
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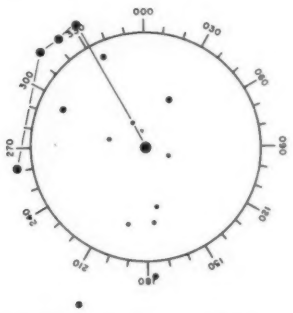
RIGEL



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10N	078	071	045	326	292	283	-	-	-	-	-	-
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20S	109	110	126	223	249	252	-	-	-	-	-	-
30S	119	122	145	206	235	240	-	-	-	-	-	-
40S	129	135	156	196	223	230	-	-	-	-	-	-
50S	140	146	164	191	212	220	-	-	-	-	-	-
60S	150	155	169	187	203	210	209	-	-	-	-	-
70S	160	164	174	185	194	200	200	-	-	-	-	161
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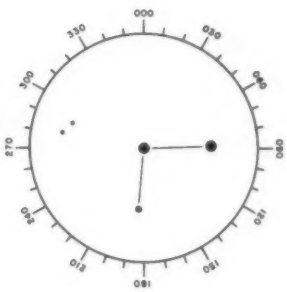
RIGIL KENTAURUS



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60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
30N	-	-	-	-	-	-	-	-	-	-	-	-
20N	-	-	-	-	-	-	037	009	341	314	-	-
10N	-	-	-	-	-	058	041	011	339	310	-	-
0	-	-	-	-	-	072	044	012	337	306	279	-
10S	-	-	-	-	104	078	048	013	335	302	274	-
20S	-	-	-	134	108	083	053	014	331	296	268	243
30S	214	189	162	138	114	089	060	017	327	289	262	238
40S	211	187	164	142	120	098	069	022	319	280	255	233
50S	207	187	166	146	127	108	084	034	303	267	245	226
60S	203	186	168	152	136	121	107	094	261	248	234	219
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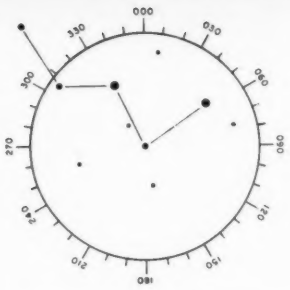
SCHEDAR



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30N	160	217	255	280	303	327	-	-	042	064	088	116
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10N	166	207	240	267	-	-	-	-	-	076	101	130
0	168	203	235	262	-	-	-	-	-	-	107	135
10S	170	202	230	-	-	-	-	-	-	-	112	138
20S	171	198	224	-	-	-	-	-	-	-	-	144
30S	171	197	-	-	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
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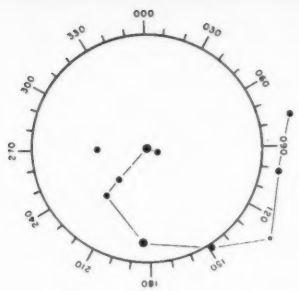
80S	-	-	-	-	-	-	-	-	-	-	-	-

SHAULA



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40N	-	-	-	-	-	-	-	-	017	354	331	-
30N	-	-	-	-	-	-	-	043	020	353	326	-
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60S	215	204	191	176	162	150	142	142	154	191	215	220
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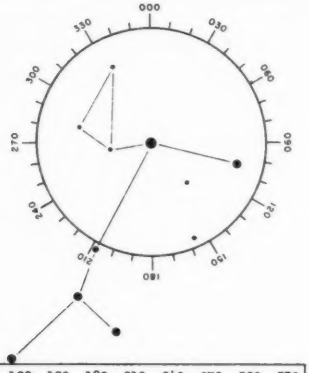
SIRIUS



LHA / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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50N	-	037	026	007	347	330	-	-	-	-	-	-
40N	-	047	032	009	342	322	-	-	-	-	-	-
30N	-	056	040	012	337	314	301	-	-	-	-	-
20N	-	065	049	016	330	305	292	-	-	-	-	-
10N	-	074	059	021	321	295	282	-	-	-	-	-
0	-	085	072	033	308	283	273	-	-	-	-	-
10S	-	095	087	059	285	271	263	-	-	-	-	-
20S	-	105	102	115	255	258	252	-	-	-	-	-
30S	121	116	118	149	229	244	243	-	-	-	-	-
40S	131	128	133	162	212	230	232	-	-	-	-	-
50S	140	138	146	169	201	218	221	217	-	-	-	-
60S	150	149	157	173	193	207	211	209	-	-	-	-
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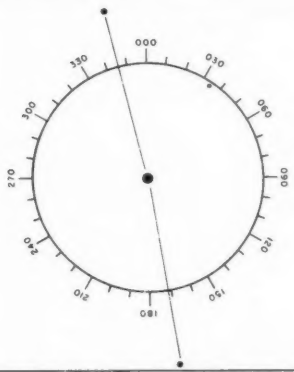
SPICA



LHA / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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60S	-	-	-	152	149	154	167	187	203	210	210	-
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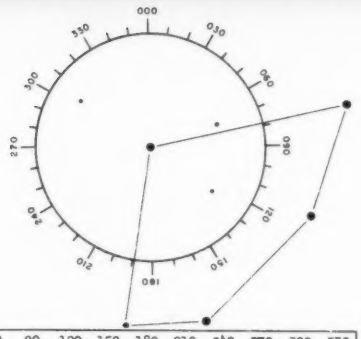
SUHAIL



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	012	350	-	-	-	-	-	-
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30S	-	122	104	084	048	317	277	256	239	-	-	-
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50S	153	137	126	117	125	233	243	235	224	208	189	171
60S	158	147	138	137	154	203	223	222	214	203	188	173
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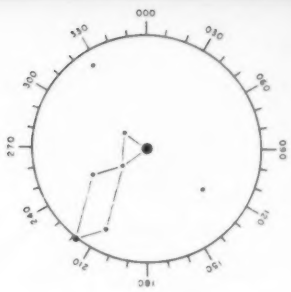
80S	171	167	166	169	175	184	191	194	193	189	184	177

VEGA



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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70N	334	339	347	357	008	017	024	025	020	005	346	336
60N	322	330	342	356	011	024	035	040	035	011	334	322
50N	310	322	337	-	014	031	044	053	053	023	315	306
40N	300	314	-	-	-	037	053	065	074	069	284	290
30N	290	307	-	-	-	-	061	076	093	138	253	275
20N	284	-	-	-	-	-	070	087	107	157	232	263
10N	273	-	-	-	-	-	077	095	120	163	221	253
0	265	-	-	-	-	-	-	104	128	168	213	245
10S	257	-	-	-	-	-	-	112	136	170	208	236
20S	-	-	-	-	-	-	-	119	141	171	204	230
30S	-	-	-	-	-	-	-	-	146	173	200	223
40S	-	-	-	-	-	-	-	-	151	174	197	-
50S	-	-	-	-	-	-	-	-	-	175	194	-
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70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

Excuse our oversight

In our Summer 1986 issue, the volume indicated on the cover and masthead should have been XXXIII.

If you planned to submit a manuscript to THE NAVIGATOR, the Directorate of Operations, HQ USAF, recommends you forward your articles to other periodicals such as Flying Safety, TAC Attack, The MAC flyer, Combat Crew, etc. The following list of addresses should prove helpful.

TAC Attack, TAC/SEP, Langley AFB, VA 23655

Flying Safety, AFISC/SEDF, Norton AFB, CA 92409

USAF Fighter Weapons Review, USAF FWS/COAR, Nellis AFB, NV 89191-5000

Combat Crew, HQ SAC/IGFE, Offutt AFB, NE 68113-5001

The MAC Flyer, HQ MAC/IGFE, Scott AFB, IL 62225-5101

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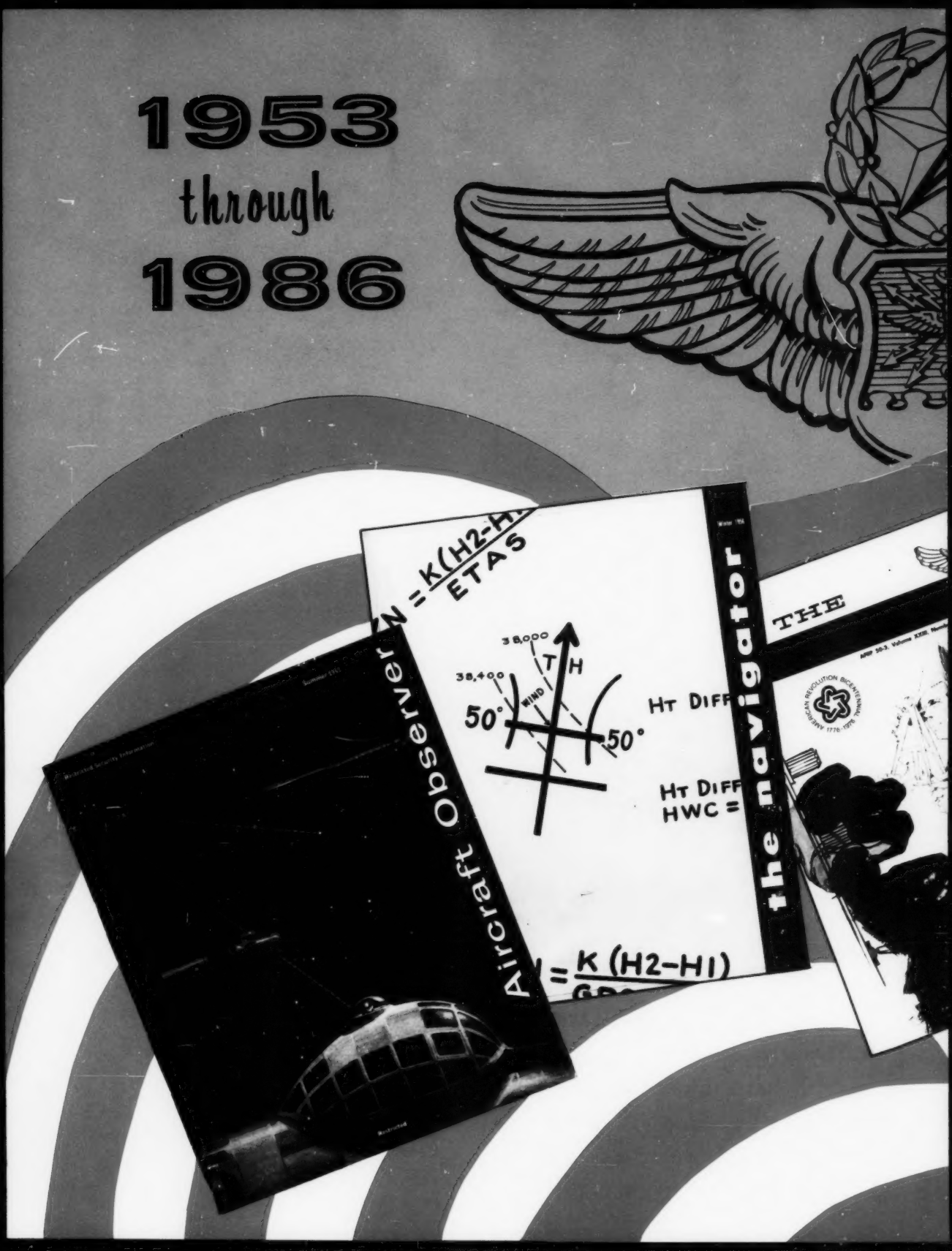
1953 through 1986